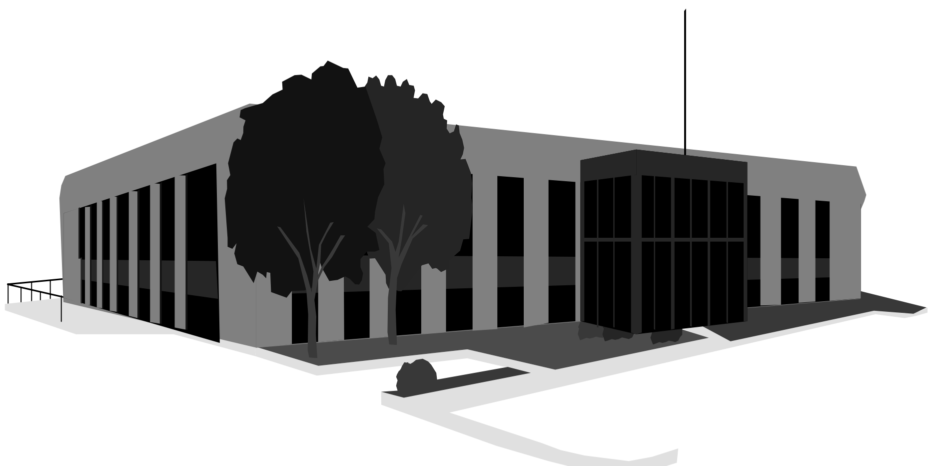
INDOOR AIR QUALITY ASSESSMENT

North Andover Town Hall
120 Main Street
North Andover, Massachusetts



Prepared by:
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Bureau of Environmental Health Assessment

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Background/Introduction

At the request of Sandra Starr, North Andover Board of Health Agent, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at North Andover Town Hall (the town hall), 120 Main Street, North Andover, Massachusetts. On February 15, 2001, a visit was made to this building by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA to conduct an indoor air quality assessment. During the visit BEHA staff received complaints from building occupants of poor indoor air quality.

The town hall is a two-story red brick building constructed in the 1920's (see Picture 1), as an addition to the North Andover Fire Department, which was built in the 1909. The indoor air quality assessment for the North Andover Fire Department is subject of a separate report. The North Andover Town Hall first and second floors contain town offices. The basement floor is made up of town offices, a meeting room, utility closet and boiler room. Windows are openable and consist of single paned glass in wooden window frames.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor.

Results

These offices have an employee population of approximately 20. The tests were taken under normal operating conditions. Test results appear in Tables 1-2.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million of air (ppm) in all but two areas sampled, which indicates adequate air exchange in most areas. No general mechanical ventilation systems exist on the first and second floors of the building. Basement offices were retrofitted with a mechanical ventilation system. Each room has a radiator beneath the window that provides heat. The sole source of fresh air is through openable windows. With the lack of exhaust ventilation, pollutants that exist in the interior space can build up and remain inside the building.

During summer months, ventilation in the town hall is controlled by the use of openable windows. The town hall was configured in a manner to use cross-ventilation to provide comfort for building occupants. The building is equipped with windows on opposing exterior walls. In addition, the building has hinged windows located above the hallway doors. This hinged window (called a transom) enables the classroom occupant to close the hallway door while maintaining a pathway for airflow. This design allows for airflow to enter an open window (windward side), pass through a room, pass through the open transom, enter the hallway, pass through the opposing open room transom, into the opposing room and exit the building on the leeward side (opposite the windward side) (see Figure 1). With all windows and transoms open, airflow can be maintained in a building regardless of the direction of the wind. This system fails if the windows or transoms are closed (see Figure 2).

Ventilation in basement offices is provided by an air-handling unit (AHU) located in the boiler room. Fresh air is supplied to rooms in the basement by ceiling mounted air diffusers. Air is returned to the AHU by wall mounted grilles. The AHU draws in air near ground level through the make-up air vent that services the furnace (see Picture 2). The town hall basement AHU does not appear to be designed to have mechanical exhaust ventilation that will remove stale air from offices. Without exhaust ventilation, pollutants that exist in the interior space will be recirculated and can build up and remain inside the basement offices. An air conditioning unit also exists in a closet in the basement in the front of the building. This system appears to have the capability of introducing fresh air or providing exhaust ventilation.

In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last servicing and balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be rebalanced every five years. (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings were measured in a range of 69^{o} F to 74^{o} F, which were very close to the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Some offices, such as the tax collector's office, were reconfigured so that airflow to the hallway was altered (see Figure 3). One window that formerly opened to the hallway was enclosed with a recessed front desk and subdivision of the office floor space. The new front desk has glass installed with narrow windows, which restricts airflow. In addition, the tax collector's office contained at least six computer monitors, one fax machine and one photocopier. Each of these electronic devices can produce waste heat, which is expelled into the office space while operating. With the reconfiguration, the ability for air to flow to and from the tax collector's office is restricted.

The relative humidity in the building was below the BEHA recommended comfort range of 40 to 60 percent in all areas sampled the day of the assessment. Relative humidity measurements ranged from 23 to 27 percent. The sensation of dryness and irritation is common in a low relative humidity environment. For buildings in New England, periods of low relative humidity during the winter are often unavoidable.

Microbial/Moisture Concerns

A floor tile in the accounting/payroll office was loosened by collection of water beneath the tile. No other area in the basement had loosened tiles. No apparent source, other than water penetration through the foundation could be identified. Chronic water penetration in this manner can serve as a media for mold growth and needs to be remediated.

A factor that may be contributing to moisture noted in the basement is water accumulation along the base of a building. The following conditions can lead to subsequent water accumulation along the base of the building, which can lead to moisture penetration into the basement:

- Soil along the base of the building has a deep furrow caused by rainwater runoff from the building wall (see Picture 3), which is evidence of poor drainage.
- A damaged downspout exists on the front of the building (see Picture 4).
- The condensation drain for the air-conditioning system also exits the building through a basement office window frame along the exterior wall base near the chiller (see Picture 5).
- Shrubbery in direct contact with the exterior wall brick was noted along the front of the building (see Picture 6). Shrubbery can serve as a possible source of water impingement on the exterior curtain wall due to the location of plants growing directly against the building. Plants retain water and in some cases can work their way into mortar and brickwork causing cracks and fissures, which may subsequently lead to water penetration and possible mold growth.

Each of these conditions allows for the accumulation of water along the base of the building, which can lead to moisture penetration into the basement.

Several areas had a number of water-damaged ceiling tiles as well as wall plaster. Window frames appear to be original and also exhibit signs of water damage. Water damage to the interior can be through leaks through the window frames. Porous building materials (e.g., ceiling tiles and wall plaster) can serve as growth media for mold, especially if wetted repeatedly. These materials should be replaced after a water leak is discovered.

Other Concerns

The fresh air intake for the basement AHU is located in half of the original makeup air vent for the furnace. The vent for the AHU is located within the louver of the shared furnace makeup air vent. In this configuration, the AHU has the potential to draw air and related pollutants from the boiler room.

Missing and ajar ceiling tiles, as well as spaces and holes in the interior walls and floors were observed. Since wall cavities are unconditioned space and would be expected to have a lower temperature than heated offices, drafts of air moving from the wall interiors into rooms may occur. Particulates can move with airflow from the interior of the wall cavity into the room. Each of these breaches in the floors and walls can be a means for odors and particles to move from one area to another. The town hall has a crawl space that can be accessed from an opening within the basement of the fire station (see Picture 7). Stored in the firehouse basement are several pieces of fossil fuel powered equipment, including the emergency electrical generator. This opening between the buildings can serve as a means for odors to move from the fire station basement into the town hall crawlspace. Once in the crawlspace, pollutants could potentially move into the ground and first floor through spaces in floors or walls.

Offices throughout the building contain computers, photocopiers and fax machines. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt-Etkin, D., 1992). As discussed previously, without mechanical ventilation, excess heat, odors and pollutants produced by office equipment can build up and lead to indoor air quality complaints.

Conclusions/Recommendations

In view of the findings at the time of the visit, health and building complaints are consistent with what might be encountered in a dry environment without mechanical ventilation. In order to improve indoor air quality the following recommendations are made:

1. Seal the crawlspace entrance in the fire station basement.
2. Examine the feasibility of installing a return air vent in the basement meeting room.
3. Examine the feasibility of extending the fresh air intake outdoors for the basement AHU in a manner to separate it from the furnace make up air vent.
4. Examine the feasibility of installing exhaust ventilation in the basement offices.
5. Remove the floor tile in the accounting office of the basement to determine the source of water penetrating through the basement floor.
6. Open windows on the first and second floors to provide fresh air.
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is

recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

8. Use transoms to enhance airflow during warm weather. Be sure to close transoms at the end of business hours. To aid in the draw of fresh outdoor air in warm weather, use portable fans directing air out windows on the leeward side (opposite the windward side) of the building. Fans positioned in this manner will serve to increase the draw of outdoor air across the first and second floors without interfering with the natural internal airflow pattern of the building.
9. Repair damaged window frames to prevent water penetration into the building.
10. Replace water damaged and missing ceiling tiles.
11. Repair downspout system.
12. Improve drainage along the exterior wall to direct rainwater away from the base of the building.
13. Extend the condensation drain to empty at ground level to prevent water splashing and further damage to window frame.
14. Cut back or consider removing shrubbery from the exterior wall of the front of the building.

References

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Figure 1 **Cross Ventilation in a Building Using Open Windows and Transoms**

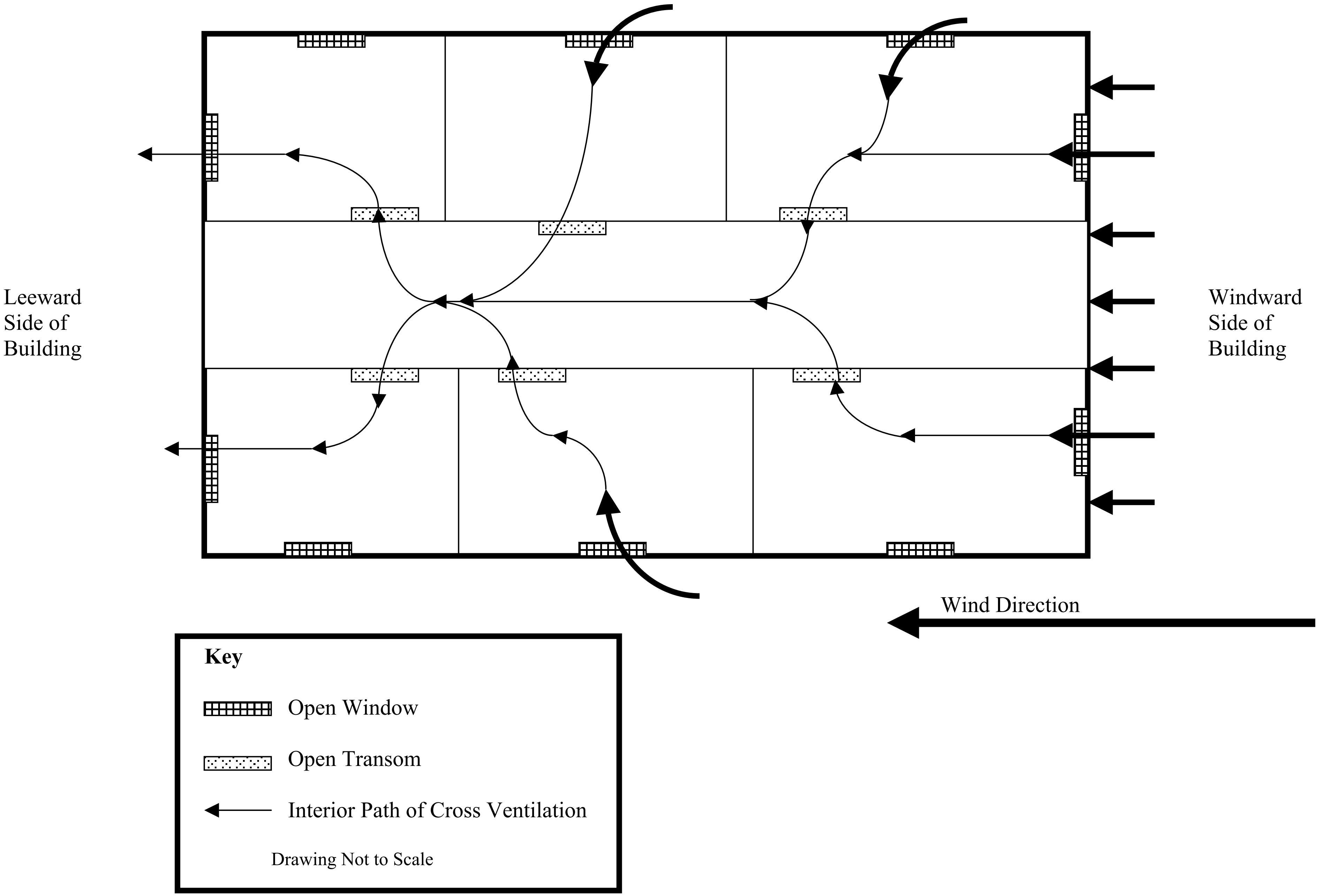


Figure 2 **Inhibition of Cross Ventilation in a Building with Several Windows and Transoms Closed**

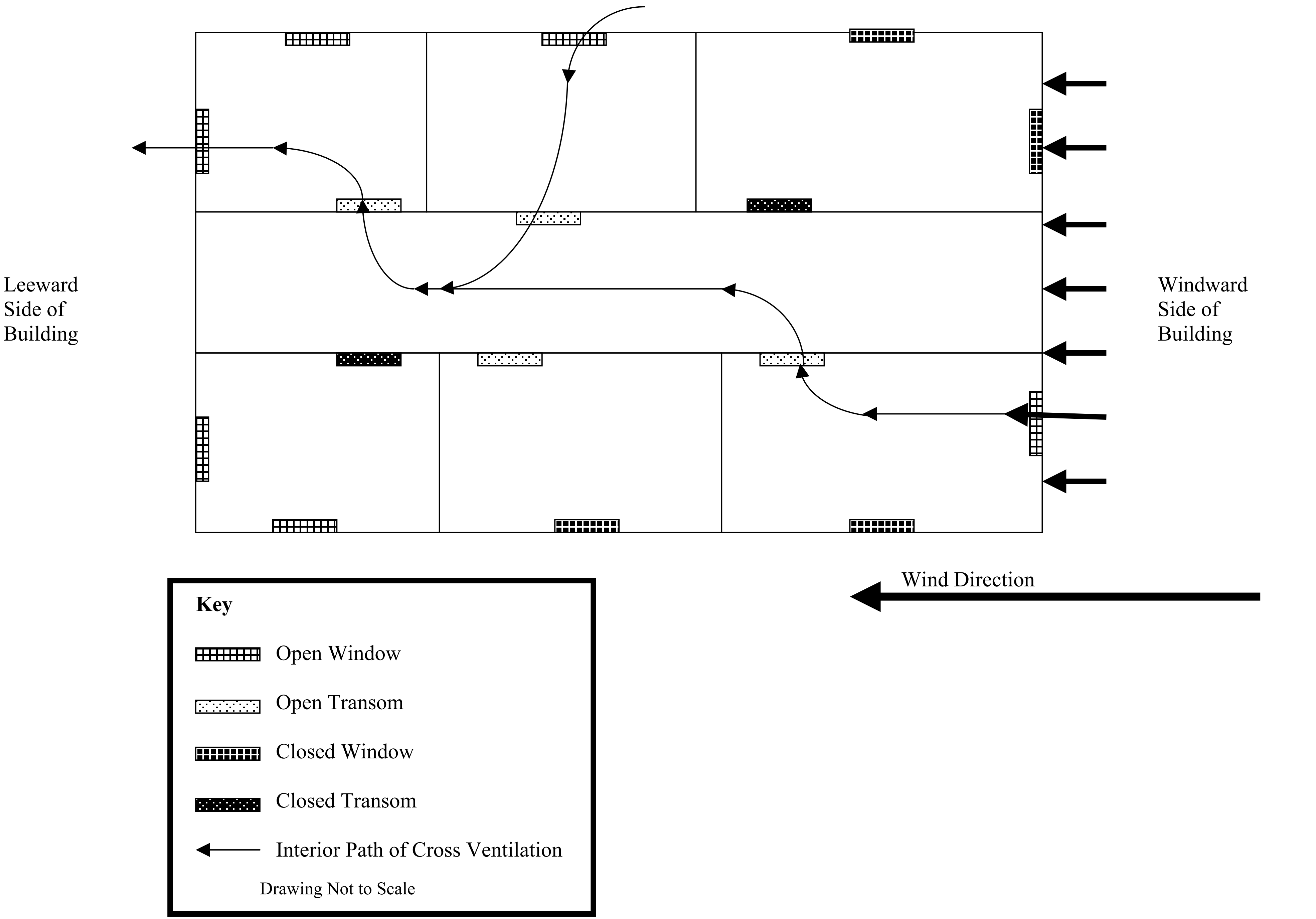
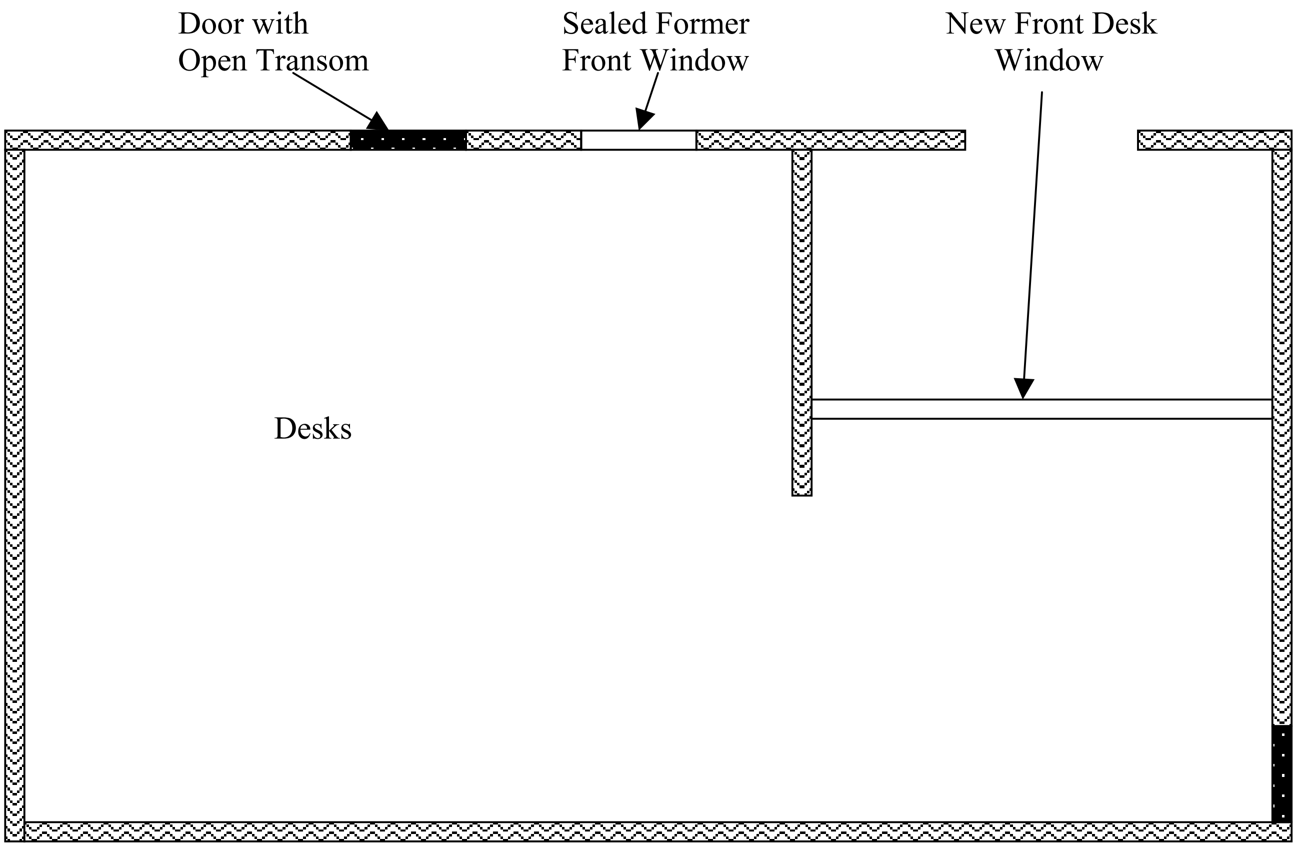


Figure 3 **Configuration of Tax Collector's Office**



Picture 1

North Andover Town Hall

Picture 2

Shared Fresh Intake/Make-Up Air Vent

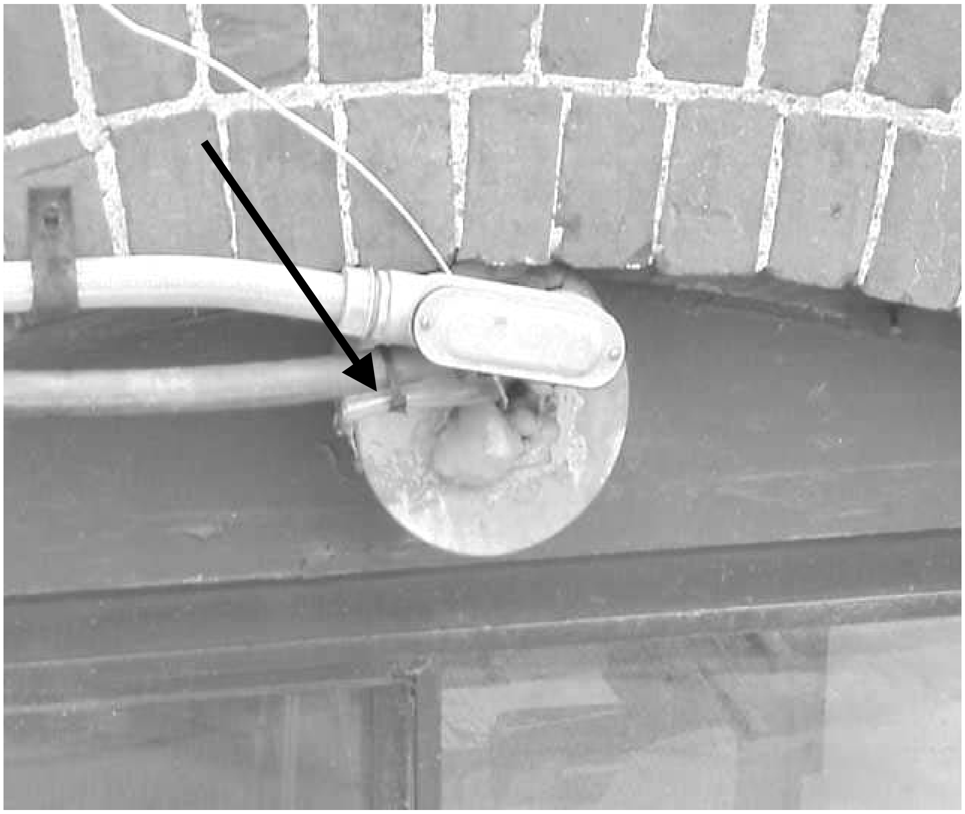
Picture 3

Furrow from Rainwater Runoff

Picture 4

Damaged Down Spout at Front of Building

Picture 5



Air-Conditioner Condensation Drain

Picture 6

Shrubbery against Exterior Wall

Picture 7

Hole in Town Hall/Fire Station Shared Wall

TABLE 1

Indoor Air Test Results – North Andover Town Hall, North Andover, MA – February 15, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	398	41	26					
MIS	763	69	27	0	Yes	No	No	Transom closed, door open
Training Room	758	70	25	0	Yes	No	No	Transom closed, 2 water damaged CT, water damaged plaster, 5 computers
Assessor's Front Office	751	70	23	4	Yes	No	No	Transom closed, window open
Assessor's Office	695	70	23	1	Yes	No	No	Transom closed, 2 water damaged CT, water damaged plaster, holes in floor
Veteran's Office	853	71	25	2	Yes	No	No	Transom closed, 2 water damaged CT, water damaged plaster, door open
Copier Room	724	72	25	0	Yes	No	No	Photocopier
Tax Collector's Office	722	71	24	4	Yes	No	No	Transom open, 1 missing CT, 1 CT ajar, 4 computers, photocopier odor, window open
Town Clerk – Main Office	875	74	24	3	Yes	No	No	Transom open, 2 water damaged CT, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – North Andover Town Hall, North Andover, MA – February 15, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Town Clerk – Private Office	763	73	23	1	Yes	No	No	Transom open, door open
Accounting/Payroll	553	70	20	2	Yes	Yes	Yes	Bubbled floor tile-possible water, door open
Library/Conference Room	530	70	20	0	Yes	Yes	No	
Assessor's Office Annex	595	70	20	1	Yes	Yes	Yes	Door open
Break Room		522	69	21	0	Yes	No	No
Inner Office – Town Manager	644	70	22	1	Yes	No	No	Door open

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